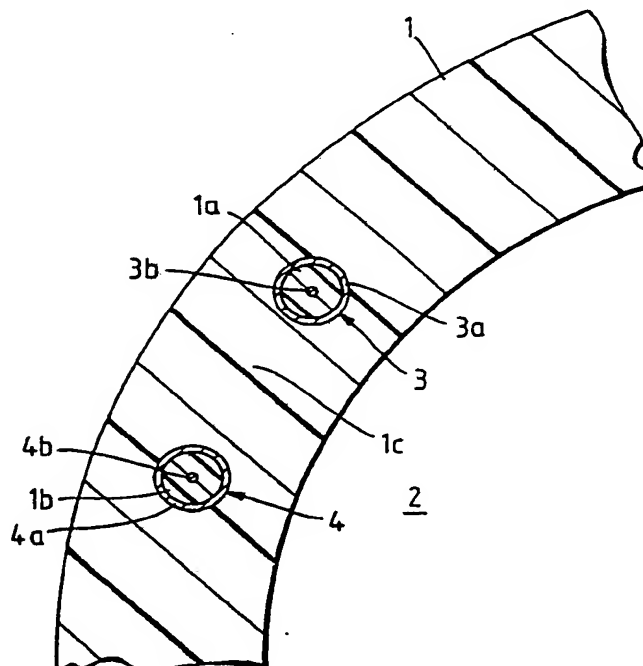




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/GB90/00749</p> <p>(22) International Filing Date: 15 May 1990 (15.05.90)</p> <p>(71) Applicant (for all designated States except US): CIRCULATION RESEARCH LIMITED [GB/GB]; 6A Shenley Road, Boreham Wood, Hertfordshire (GB).</p> <p>(72) Inventors; and</p> <p>(75) Inventors/Applicants (for US only) : KITNEY, Richard, Ian [GB/GB]; 78 Waldemar Avenue, Fulham, London SW6 (GB). STRAUGHAN, Keith [GB/GB]; 29 Chiltern Park Avenue, Chiltern Park, Berkhamsted, Hertfordshire HP4 1EU (GB). ROTHAM, Martin, Terry [GB/GB]; 207 East Dulwich Grove, London SE22 (GB).</p> <p>(74) Agents: BERESFORD, Keith, Denis, Lewis et al.; Beresford &amp; Co., 2-5 Warwick Court, High Holborn, London WC1R 5DJ (GB).</p>		<p>(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent)*, DK (European patent), ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), NO, SE (European patent), US.</p> <p>Published With international search report.</p>

(54) Title: CATHETERS



## (57) Abstract

A catheter of the kind which carries an electrical ultrasonic transducer arrangement at its distal end which transducer arrangement is energised via electrical leads extending the length of the catheter is characterised in that either the leads (3, 4) comprise microcoaxial cables embedded in the wall (1) of the catheter or there are leads carried in a lumen of the catheter which lumen has its walls coated with a metallic electrically screening coating.

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CATHETERS

The present application relates to catheters generally and in particular to catheters which are suitable for use with the system disclosed in our copending UK  
5 Patent Application Nos 8714450 and 8726440, and in our copending International Patent Application No GB88/00971.

In those co-pending patent applications a catheter  
10 having the following features is disclosed:

- (a) a probe carried at one end of the catheter;
- (b) an ultrasonic transducer arrangement in the form  
15 of an annular assembly of the transducer elements which encircle the probe at or near one of its ends; and
- (c) means to electrically connect the transducer  
20 elements to the other end of the catheter, which means either incorporates a multiplexing/demultiplexing circuit as such or comprises a wiring arrangement which has the effect of acting in a multiplexing or demultiplexing way, the purpose of either the circuit  
25 or the arrangement being to reduce the number of wires which run the length of the catheter.

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There can be other situations in which it is desired to run electrical leads the length of the catheter in order to energise some item carried at the distal end of the catheter or to receive signals generated at the  
5 distal end, the distal end being that which is within the patient and remote from the so-called proximal end which would in use be manipulated by the medical practitioner or technician.

10 In such situations there can be problems in accommodating the electrical leads given the small diameter of the catheter. Normally such leads pass down the central "lumen" or bore of the hollow catheter.

15 As indicated earlier in connection with our co-pending patent applications the number of wires can be reduced by employing a multiplexing/demultiplexing arrangement.

20 According to a first aspect of the present invention a catheter has at least one coaxial electrical lead embedded in the wall of the catheter and running the length thereof.

25 According to a second aspect of the present invention a

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catheter has at least one lumen whose walls have a metallic electrically screening coating and which lumen has at least one electrical lead passing through it.

5

According to a third aspect of the present invention a catheter has at least one lumen with at least one electrical lead passing through it, the wall of the catheter having embedded therein an electrically  
10 conducting wire mesh which is adapted to form part of an electrical circuit together with the said electrical lead.

15

According to a fourth aspect of the present invention a catheter has one or more lumens which contain one or more electrical leads, the wall of the catheter having embedded therein a wire mesh member which in use is adapted to act as an electrical screening member in relation to the electrical lead or leads passing  
20 through the lumen or lumens.

20

How the invention may be carried out will now be described by way of example only and with reference to the accompanying drawings in which:

25

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Figure 1 shows a catheter to which the present invention can be applied;

5        Figures 2A and 2B show diagrammatically an arrangement of ultrasonic transducers;

10       Figure 3 is a fragmentary enlarged cross-sectional view of a catheter constructed according to a first aspect of the present invention;

15       Figures 4A and 4B is a cross sectional view of a catheter constructed according to a second aspect of the present invention; and

20       Figure 5 is part of a circuit diagram illustrating the application of a third aspect of the present invention.

Figure 1

20

25       This illustrates a typical known type of catheter which consists of a plastic tube 1 which has a handle 101 at its proximal end and a tip member 102 at its distal end. A guide wire 103 can be passed through the tube 1. The handle 101 is provided with an axially located aperture 104 through which the guide

- 5 -

wire 103 can pass. The handle 101 is also provided with further radially located apertures 105 and 106 through which other devices or materials can be introduced into the catheter tube 1.

5

Figure 2

In the manner described in more detail in our  
aforementioned copending applications the distal end  
10 of the catheter is provided with an array of  
electrical ultrasonic transducer elements, in this  
case twelve indicated in figures 2A and 2B as A1, B1,  
C1, A2, B2, C2, A3, B3, C3, A4, B4 and C4 arranged in  
the configuration shown in figure 2A.

15

As explained in more detail in our copending  
applications the twelve transducers are electrically  
connected in such a way that they are "fired" in  
groups of four. More specifically the group A1, A2,  
20 A3 and A4 are fired together, the group B1, B2, B3 and  
B4 are fired together and the group C1, C2, C3 and C4  
are fired together, these three groups being "fired"  
in turn one after the other.

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Figure 2B illustrates diagrammatically one possible arrangement for wiring up these three groups of transducers in order to "fire" in the manner indicated above. For simplicity this wiring arrangement shows  
5 only one common lead A for the transducers A1 to A4, one lead B for the transducers B1 to B4 and only one lead C for the transducers C1 to C4.

The various aspects of the present invention are not  
10 limited to any particular wiring arrangement and figures 2A and 2B have only been included in order to give some background information to the context in which the present invention can be employed.

15 Figure 3

A catheter comprises a tube 1 made of a suitable thermoplastic material such as Nylon (Registered Trade Mark), which tube 1 defines a central "lumen" or bore  
20 2.

Alternatively the catheter could have a number of mutually parallel lumens as illustrated in figures 5A, 5B and 5C of our co-pending UK Patent Application No  
25 8714450. As described in the patent specification of that application the various lumens are provided for

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different purposes associated with a particular clinical use to which the catheter is to be put.

5 In the catheter illustrated in figure 3 microcoaxial cables 3 and 4 are embedded in the material of the catheter wall 1.

10 Each microcoaxial cable consists of an outer conductor 3a and 4a respectively and an inner or central conductor 3b and 4b respectively. The inner and outer conductors are electrically insulated from one another by the material 1a and 1b of the wall 1 of the catheter. The material 1c between the adjacent microcoaxial cables also electrically insulates each  
15 microcoaxial cable from the next adjacent microcoaxial cable.

20 By this arrangement it is possible to either accommodate more electrical conductors within a given diameter of catheter or alternatively for a given number of electrical conductors to reduce the overall diameter of a given catheter.

25 Clearly any number of microcoaxial cables could be incorporated in the wall of the catheter, within the physical limits involved.

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Instead of using Nylon (Registered Trade Mark) a polyimide plastic may be employed for the construction of the catheter tube 1.

5      Figure 4

10      This embodiment illustrates a catheter which again is adapted to carry ultrasonic transducers of the kind disclosed in our above referred to co-pending applications and shown diagrammatically in Figure 2.

In order to energise the twelve transducers there are twelve sets of electrical leads which pass through the length of the catheter tube 1.

15

The catheter comprises a thermoplastic tubular member 1 which has a central lumen 5 and four further lumens 6, 7, 8 and 9.

20      Each of the lumens 6 to 9 has passing through it three pairs of electrical leads, 10, 11 and 12 in lumen 6, 13, 14, 15 in lumen 7, 16, 17 and 18 in lumen 8 and 19, 20 and 21 in lumen 9.

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Each of the pairs of electrical leads is connected to an associated ultrasonic transducer at the distal end of the catheter in order to energise that transducer.

5

As described earlier with reference to Figure 2 one mode of operating the ultrasonic transducers, (described in more detail in our above mentioned copending applications) involves four of the twelve  
10 transducers being energised at a time. For example, in this embodiment the transducers A1 to A4 would be associated with the pairs of electrical leads 10, 13, 16 and 19 respectively and would be energised at one time, the transducers B1 to B4 would be associated  
15 with the pairs of electrical leads 11, 14, 17 and 20 respectively and would be energised at another time and finally the four transducers C1 to C4 would be associated with the pairs of electrical leads 12, 15, 18 and 21 respectively and could be energised at a  
20 further time, and so on.

In order to prevent, or at least minimise, cross-talk between the sets of transducers being energised at any given time, each of the four lumens 6, 7, 8 and 9 has  
25 its walls coated with a metallic coating, indicated at

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22, 23, 24 and 25 respectively in figure 4B which is an enlarged fragmentary view of part of figure 4A.

5 This metallic coating could consist of silver particles distributed within a thermoplastic material. This coating could be added at the time of extrusion of the catheter.

10 The outer wall portion 26 of the catheter 1 has embedded into it along its length a substantially tubular metal mesh member 27 which, as well as acting as a reinforcement for the catheter wall, also can serve as an electrical earth (ground) for the electrical circuit containing the transducers and  
15 their associated electrical leads.

In a modification of the embodiment shown in figure 4 each of the electrical leads 10 to 21 consists of a single and not a double lead, the wire mesh 27 then  
20 also serving as the return lead with respect to the single leads 10 to 21.

This latter modified arrangement is shown diagrammatically in the circuit diagram of figure 5 in  
25 which three of the twelve ultrasonic transducers A1, B1 and C1 are shown together with their associated

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electrical input leads 10, 11 and 12 respectively and the single metal mesh return lead 27 which also acts as an earth (ground). As a modification to the arrangement shown in figure 5, the wire mesh 27 could actually be on the outside surface of the catheter tube in order to simplify the manufacture of the catheter. However, in that case, it would be necessary to provide means for ensuring that the wire mesh 27 was well isolated from any electrical source at the proximal end of the catheter, such as an amplifier. One way of achieving this would be to include an opto isolator device at the distal end.

Although the invention has been described with reference to a catheter having twelve transducers a smaller or larger number, such as thirty-two, could be employed.

The invention could be used in connection with any type of catheter where electrical leads pass the length of catheter in order to energise and/or control a device at the distal end of the catheter.

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CLAIMS

1. A catheter of the kind which has an electrical lead extending longitudinally thereof within the wall of the catheter tube is characterised in that the electrical lead comprises a microcoaxial cable.
2. A catheter as claimed in claim 1 in which the material of the wall of the catheter tube is also between the central and outer conductors of the microcoaxial cable in order to electrically insulate the inner and outer conductors from one another.
3. A catheter as claimed in either claim 1 or 2 which includes a plurality of microcoaxial cables extending longitudinally of the catheter within the wall thereof.
4. A catheter of the kind which has at least one lumen through which an electrical lead passes, is characterised in that the wall of the lumen has a metallic coating which in use is adapted to act as an electrical screen.

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5. A catheter of the kind having at least one electrical lead passing through at least one lumen characterised in that there is embedded in the wall of the catheter an electrically conductivity wire mesh which in use is adapted to form part of an electrical circuit together with the said electrical lead.

6. A catheter as claimed in claim 5 in which the wire mesh is adapted to act as an electrical screening member.

7. A catheter as claimed in claim 5 or 6 which the wire mesh is adapted to act as an electrical return.

8. A catheter as claimed in claim 4 having at its distal end a plurality of electrical ultrasonic transducers and a plurality of electrical leads extending through one or more lumens in the catheter in order to energise the transducers, the lumen or lumens containing the electrical leads having a metallic coating on their inner walls to provide electrical screening when in use.

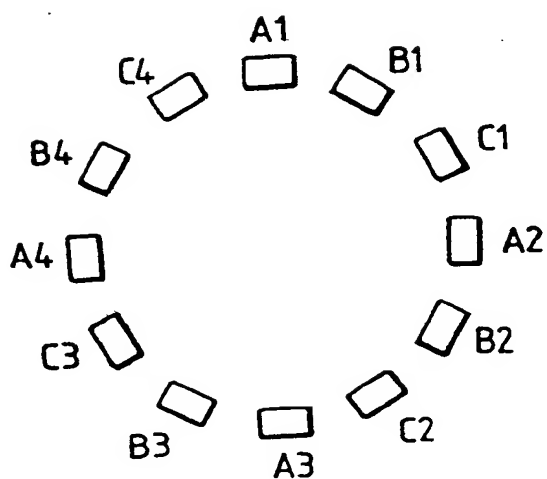
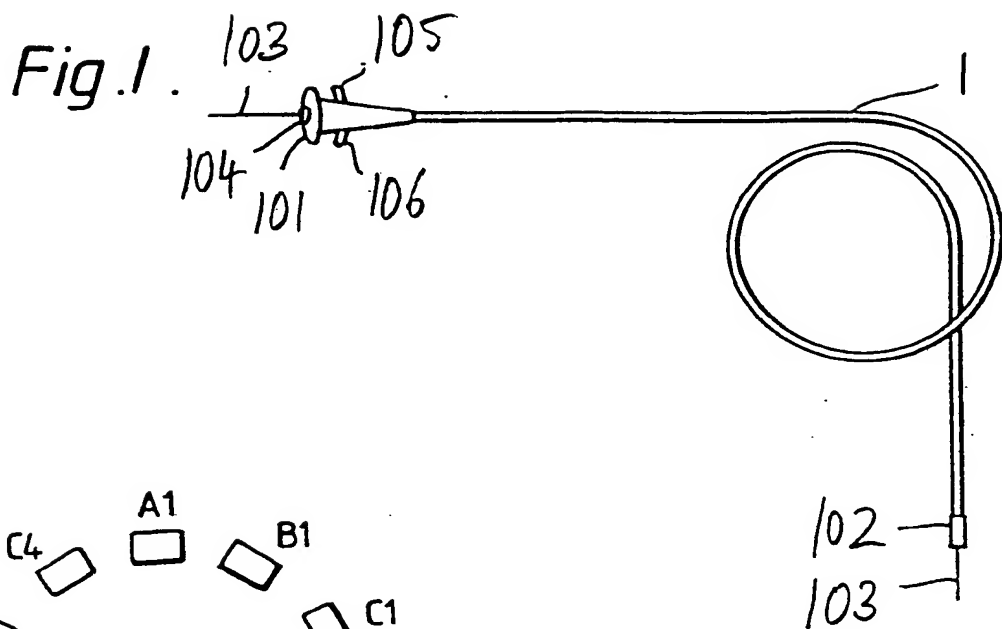
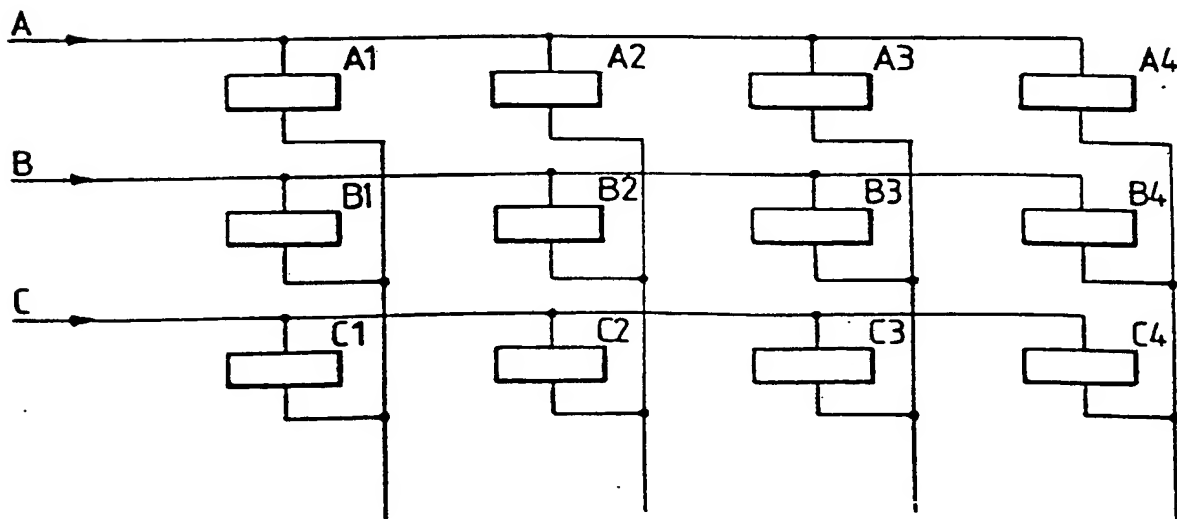


Fig. 2A

FIG. 2B



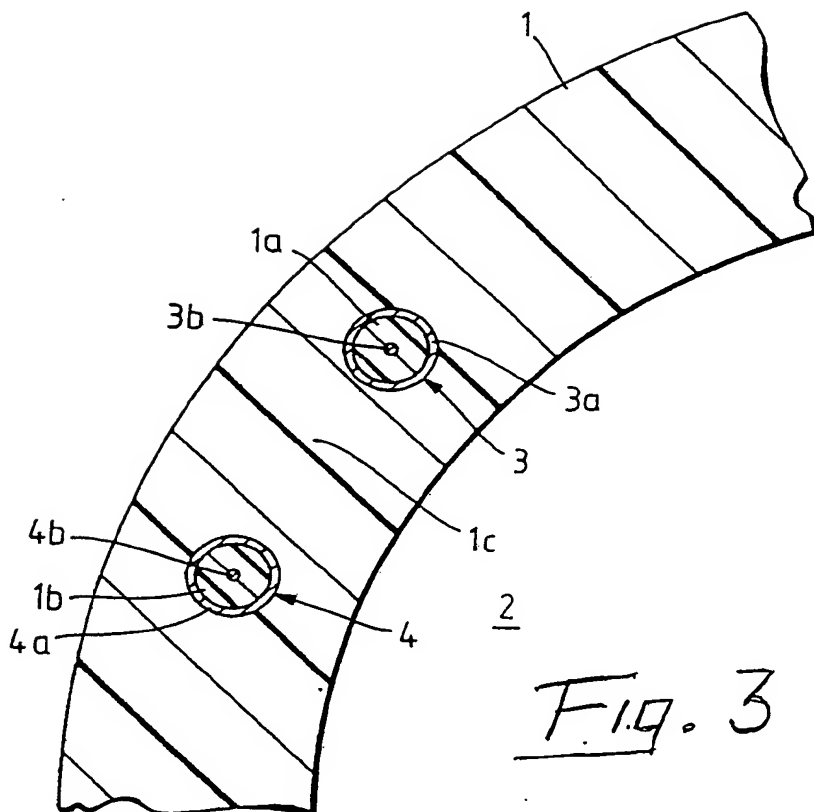


Fig. 3

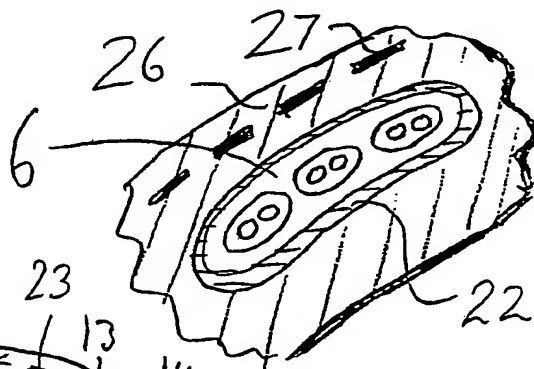


Fig. 4B

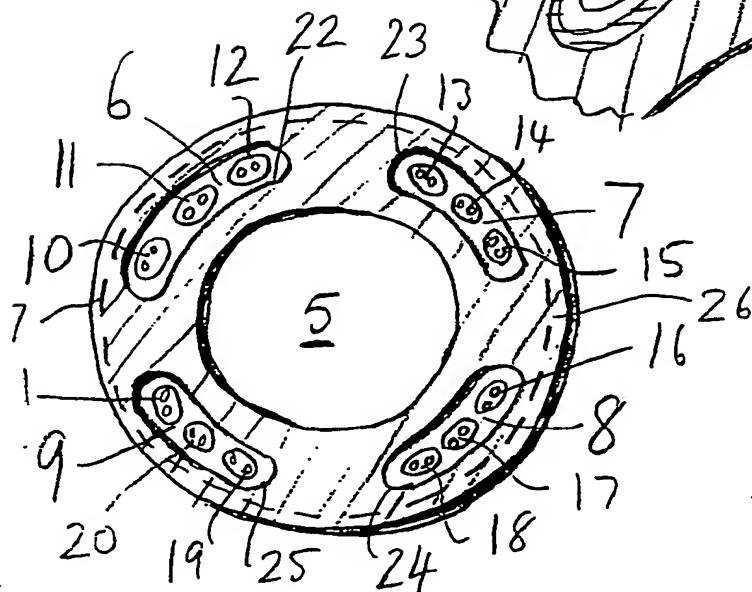


Fig. 4A

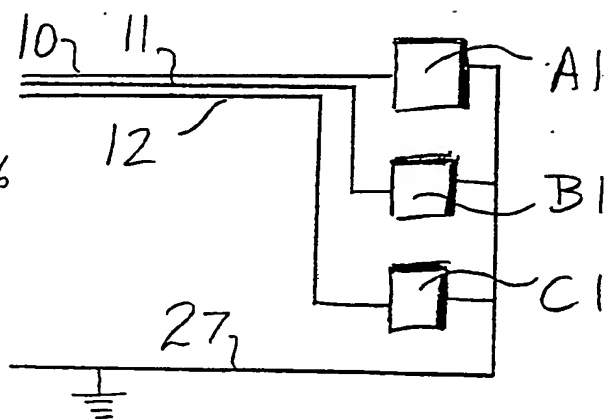


Fig. 5

## INTERNATIONAL SEARCH REPORT

International Application No.

PCT/GB 90/00749

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5                      A61M25/00		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	A61M	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X	US,A,4319580 (COLLEY) 16 March 1982 see abstract see column 6, lines 1 - 9 see column 8, lines 6 - 10; figures 3, 4, 8	1
Y	---	2-4
X	US,A,3669095 (KOBAYASHI ET AL.) 13 June 1972 see abstract see column 3, lines 5 - 21 see column 4, lines 49 - 61; figures 1, 2, 7	5-7
Y	---	2-4
A	FR,A,2190479 (UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND) 01 February 1974 see page 5, lines 6 - 10; figure 5	4-7
A	US,A,3779234 (EGGLETON ET AL.) 18 December 1973 see abstract see column 3, lines 61 - 67; figure 2	8
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<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
19 NOVEMBER 1990	03.12.90	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	H. Ballesteros <i>H. Ballesteros</i>	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	GB, A, 1427134 (NATIONAL RESEARCH DEVELOPMENT CO.) 10 March 1976 ---	

# ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

PCT/GB 90/00749

SA 36956

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.  
The members are as contained in the European Patent Office EDP file on  
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27/11/90

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US-A-4319580	16-03-82	US-A- 4354500 US-A- 4354501 US-A- 4354502	19-10-82 19-10-82 19-10-82
US-A-3669095	13-06-72	None	
FR-A-2190479	01-02-74	GB-A- 1445678	11-08-76
US-A-3779234	18-12-73	US-A- 3817089	18-06-74
GB-A-1427134	10-03-76	None	